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Somatosensory Evoked Potential Measurements in Percutaneous Fluid Aspiration from Intraspinal Cystic Lesions

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Two patients were evaluated with somatosensory evoked potentials (SSEPs) before and after CT-guided fluid aspiration from cystic intraspinal lesions. Our objective was to use the information and the clinical response to this procedure to determine the suitability of the patients for surgical intervention. In both patients, one with a pseudomeningocele and the other with a subarachnoid cyst, improvement in their symptoms corresponded to significant changes in their SSEPs.

We believe this technique may be useful in selected cases when it is unclear whether cystic intraspinal fluid collections are responsible for the patient's symptoms. An increase in amplitude and/or decrease in latency of SSEPs, along with clinical improvement after fluid aspiration, may indicate the potential benefit of surgical intervention.

In the past, percutaneous needle aspiration of fluid from cystic intraspinal lesions, with or without the subsequent instillation of radiographic contrast material into the cysts, has been performed for diagnostic purposes, and occasionally, as a consequence of fluid removal from intramedullary lesions, neurologic improvement was noted [1–4]. Monitoring the clinical status of patients during and after aspiration was the means by which the efficacy of cyst fluid removal was determined. In two patients, we aspirated fluid from cystic intraspinal lesions under CT control, and the effects of this fluid aspiration were evaluated not only by the clinical response of the patients but by the changes in somatosensory evoked potentials (SSEPs). Significant changes in the SSEPs were observed and decisions on patient management were, in part, based on these findings. The objective of this report is to describe this technique and its potential usefulness.

Subjects and Methods

In two patients a diagnosis of an abnormal CSF-equivalent collection within the spinal canal was established on the basis of metrizamide myelography and CT. CT-guided fluid aspirations from these suspected cystic lesions were performed with the patients awake and alert. Only local anesthesia at the site of the needle puncture was used. The exact level of the cystic lesions of the spinal canal was identified on the preoperative studies, and, by using a CT digital radiograph for localization, a 22-gauge needle was advanced slowly into the spinal canal at the point where the cystic lesion was seen on the preoperative studies. The needle was advanced into the cystic lesion with the patient in the prone position (case 1) or in the lateral decubitus position (case 2). In both cases, the fluid was slowly aspirated from the lesion and the patient's neurologic status was constantly monitored. Thirty ml was removed in case 1 and 16 ml in case 2. More fluid could have been aspirated in each case, but since this was a diagnostic test and not a primary mode of treatment, and because of the proximity of the needle tip to the spinal cord, complete cyst aspiration was believed to be unwarranted. There were no complications from this procedure. The fluid was analyzed for cells, protein, and cytology.

SSEPs were obtained in case 2 by stimulating the right and left median nerves individually at the wrist with square wave pulses of 200-msec duration. The stimulus intensity was just enough to provide a visible contraction of the thenar muscles. The SSEPs were recorded

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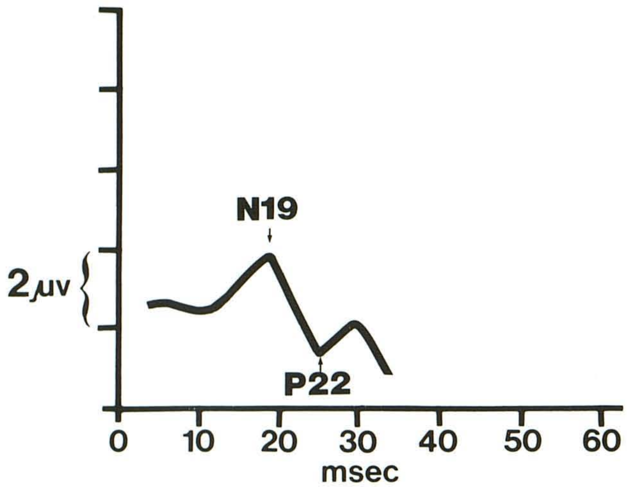

Fig. 1.—Normal somatosensory evoked potential of right median nerve. With nerve stimulation and potential recordings, typical normal waveform is shown as plot of voltage vs time. The first recorded potential (*N19*) in the upward direction occurs 16–19 msec after stimulation. The subsequent downward deflection (*P22*) occurs at 22 msec. Amplitude is measured in the y axis and latency in the x axis.

from electrodes placed on the contralateral parietal region (C3 or C4) with a midfrontal electrode (F2) as the reference. The stimulus frequency was 2 Hz with a sampling time of 200 msec; 200 to 500 responses were averaged. Runs were repeated at least twice to ensure reproducibility. The number of responses averaged was the same before and after aspiration. The amplitude and latency of waves N19 and P22 were measured (see Fig. 1 as an example of a normal SSEP) and differences between the pre- and postaspiration values were noted. Since it is important that the SSEP examination be performed with the patient in as comfortable a position as possible, the studies were performed after needle removal with the patient lying supine on the CT table. In case 1, the CZ–FZ montage was used to record the SSEPs in response to peroneal nerve stimulation at the knee, and the amplitude and latency of the waves obtained at approximately 37 msec (N/P 37) were measured. Runs were repeated before and after aspiration to ensure reproducibility of the responses.

Results

The diagnoses in our two patients were pseudomeningocele and subarachnoid cyst. In both patients significant changes were noted in SSEPs after aspiration of fluid that was equivalent to normal CSF. Cytology in each case was negative.

Case 1

A 72-year-old man had a C1–C2 laminectomy for subtotal resection of a cervical meningioma 3 years before his present admission. He had repeat surgery at the same level for tumor recurrence 1 year later. At the time of reexploration it was believed that gross tumor resection from the canal had been achieved, and a freeze-dried dural graft was used for closure. A subsequent postoperative CSF leak and staphylococcal meningitis were treated successfully with antibiotics and a lumbar CSF drain. Nine months later, progressive weakness and numbness of the left lower extremity and increasing difficulty in walking prompted hospitalization. CT of the cervical spine (Fig. 2A) showed a large pseudomeningocele in the area of prior surgery. A controversy ensued concerning whether or not the pseudomeningocele was responsible for the patient's current neurologic problems. It was decided to perform a CT-guided fluid aspiration of the pseudomeningocele and monitor the results of this fluid removal with SSEPs in an attempt to help resolve this question. After removal of approximately 30 ml of clear, colorless fluid from the pseudomeningocele (Fig. 2B), there was CT evidence that the pseudomeningocele had partially collapsed (Fig. 2C). In addition, there was improvement in the patient's neurologic status (increased left lower extremity strength and decreased numbness), and when the pre- and postaspiration SSEPs were compared, an improvement in amplitude was noted (Fig. 2D). These factors persuaded the surgeon to repair the meningocele. Neurologic evaluation on discharge and 5 months after discharge showed a neurologically improved patient with increased lower extremity strength and decreased numbness.

Case 2

A 49-year-old woman had removal of a C7–T4 spinal cord ependymoma 18 years before her present admission. Postoperative radiation (50 Gy) was given. She did well for 14 years but over the past 4 years, progressive quadriparesis and radiographic signs of tumor recurrence necessitated two separate operations, 1½ years apart, for tumor removal from C3 to C7 the first time and from C2 to C3 the second time. Postoperative chemotherapy was given after these operations. Over the past 18 months, she had noted gradual loss of strength and increased numbness in her left hand, and she developed severe cervicothoracic kyphosis.

On metrizamide CT immediately after myelography (Fig. 3A), a distorted spinal cord with an invaginated appearance of the ventral cord surface raised the possibility of a ventral subarachnoid cyst, despite the absence of significant posterior displacement of the spinal cord. Immediate filling of a large thoracic spinal cord cyst (Fig. 3B) suggested a fistulous connection between the ventral subarachnoid cyst and the syrinx. A recurrent intramedullary tumor was not suspected because the cord was not widened.

Because of the prior surgical procedures, the previous radiation therapy and chemotherapy, and the patient's general physical condition, there was a reluctance to operate unless there was strong evidence that cyst decompression could result in clinical improvement. Therefore, under CT control, a needle was directed into the spinal canal lateral to the cord (Fig. 3C) and 16 ml of clear, colorless fluid was aspirated. SSEPs before and after aspiration showed improvement in latency after stimulation of the left median nerve (Fig. 3E). Objective and subjective clinical improvement was noted immediately after fluid aspiration. The decision therefore was to operate, and at surgery a large ventral subarachnoid cyst was found. Adhesions around the cyst were lysed, and free communication with the subarachnoid space was established. In this limited surgical procedure the intramedullary cyst in the thoracic cord was not shunted, nor was an extensive exploration undertaken to find the presumed fistulous opening to that cyst. There was postoperative improvement in the patient's condition and she has remained stable over the past year.

Discussion

The monitoring of SSEPs has been used (1) during neurosurgical and orthopedic procedures [5–14]; (2) to evaluate focal or diffuse neurologic dysfunction [15–17]; (3) during interventional neuroradiologic procedures, spinal cord angiog-

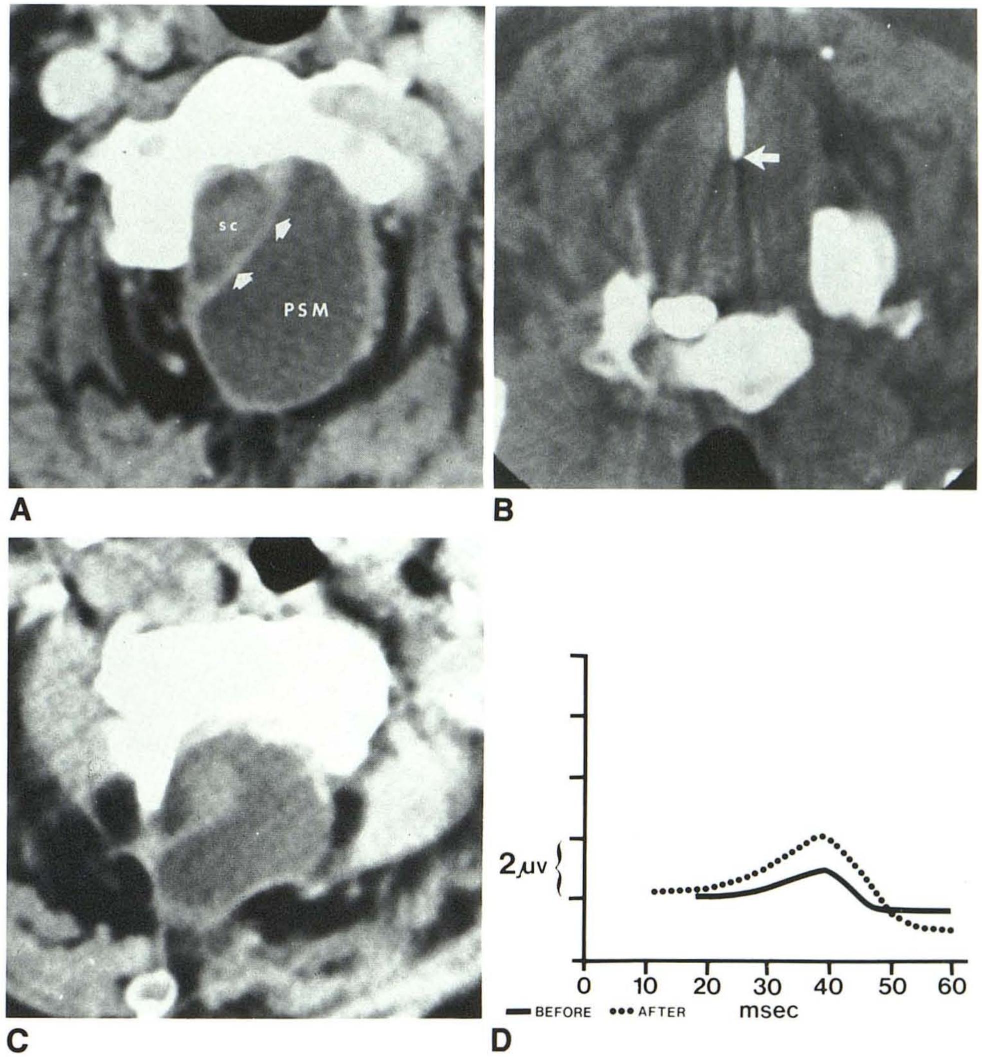

Fig. 2.—Case 1: pseudomeningocele.

A, **CT scan after IV contrast material. Large postoperative pseudomeningocele (PSM) from C1 to C3 is causing mass effect on spinal cord (sc). Fibrous band (*arrows*) separates pseudomeningocele from true thecal sac.**

B, **With patient in prone position, 30 ml of clear fluid was obtained via needle aspiration (*arrow*) from cyst.**

C, **Partial decompression of pseudomeningocele with diminished mass effect on cord is seen. (*A* and *C* are at slightly different levels, and in *C* only a portion of the fibrous band is noted.)**

D, **Somatosensory evoked potential measurements after stimulation of left peroneal nerve at the knee shows increased amplitude after aspiration. On the basis of this study and the patient's symptomatic improvement after fluid aspiration, the pseudomeningocele was resected.**

raphy, and endovascular embolizations of spinal arteriovenous malformations [18, 19]; and (4) to evaluate the effects of spinal and brain trauma [20–23]. To our knowledge, no one has used this technique in assessing the effect of aspiration of fluid from intraspinal cystic masses outside the operating room.

There is sufficient clinical and experimental evidence to suggest that the large-diameter sensory fibers in the posterior columns of the spinal cord and lemniscus system conduct the impulses responsible for the SSEPs [24]. The normal negative activity (N19) appearing in scalp electrodes between 16 and 19 msec after stimulating the median nerve at the wrist is generated in the thalamus, and the subsequent positivity (P22) is generated in the parietal sensory cortex. The normal negative activity noted 25–28 msec after peroneal nerve stimulation at the knee is thought to be generated in the thalamus, and the subsequent positive activity at 31–34 msec, generated in the parietal cortex, can be considered the equivalent of P22 seen after upper limb stimulation. Changes in SSEPs correlate well with lesions of the spinal cord and brainstem [22, 25]; specifically, impairment of joint position, even if mild, can result in abnormal SSEPs; however, SSEPs are normal in patients with lesions involving only pain and temperature sensation. SSEP abnormalities have been described in a variety of diseases and are caused by segmental demyelination, conduction block, and axonal and neuronal loss. Axonal loss produces amplitude changes without changes in latency because there is normal conduction in the remaining axons. Compressive lesions produce segmental demyelination, block of conduction, and axonal loss in varying combinations and will give rise to changes in latency, amplitude, or a combination of both in the SSEPs.

We used the physiological information that can be obtained with such a technique in the clinical management and surgical planning of two patients who had cystic lesions in the spinal canal. This procedure can find particular use when the patient has had prior surgery in the area under question and the clinical picture is not certain, as in our cases. While there may be clinical signs indicating cord dysfunction, it may be unclear whether decompression of the cystic lesion would result in

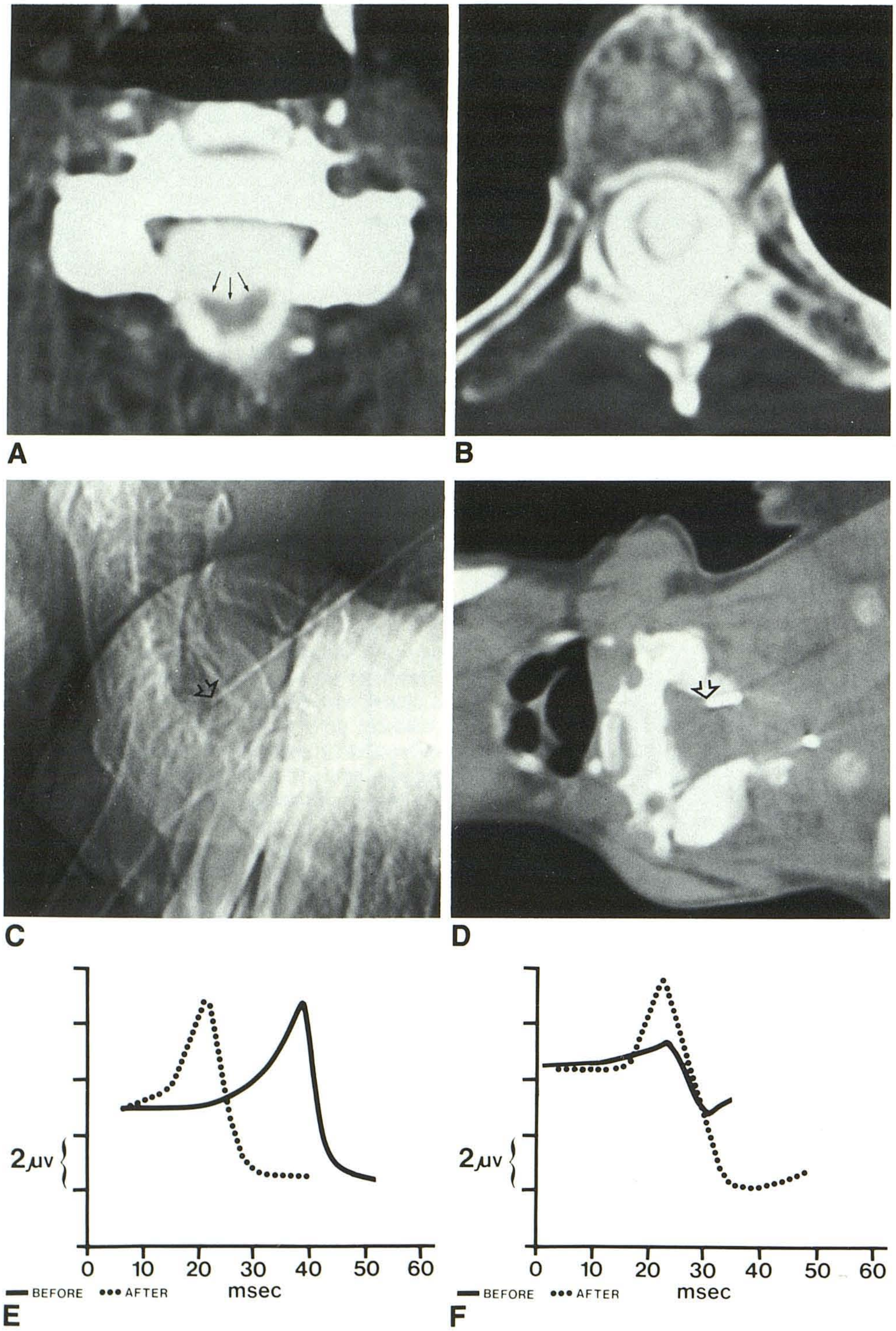

Fig. 3.—Case 2: subarachnoid cyst with fistulous connection to an intramedullary cyst.

***A* and *B*, Immediate postmyelography CT scans show possible ventral subarachnoid cyst at C5 compressing and distorting ventral surface of spinal cord (*arrows*). Rapid filling of an intramedullary cyst in low cervical and thoracic cord is seen in *B*. The possibility of a fistula connecting suspected subarachnoid cyst to cord cyst was raised.**

***C* and *D*, With patient in lateral decubitus position, the needle (*arrows*) was advanced into the spinal canal lateral to the cord.**

***E* and *F*, Postaspiration somatosensory evoked potentials from right median nerve (*E*) show improvement in latency of N19 wave and, from left median nerve (*F*), an increase in amplitude of N19 wave. Because of these changes and symptomatic improvement, surgery was performed.**

improved neurologic function. To assist in clinical management, we measured preoperatively the effect that cyst fluid aspiration had on the SSEPs in two patients. As demonstrated by our cases, a laterally or ventrally situated extramedullary mass, though not directly adjacent to the dorsal surface of the cord, can be associated with abnormal SSEPs because of transmitted mass effect, and may cause dysfunction of the posterior columns. These types of compressive lesions may give rise to changes in amplitude, latency, or both, depending on the degree of axonal loss or conduction block.

If the effect of the mass that caused the abnormal SSEPs can be lessened, and the secondary changes within the cord are not irreversible, improvement in amplitude and/or latency indicating decompression of conducting pathways would be expected, as was shown in our patients. These changes coincided with transient improvement in both patients' clinical symptoms. We cannot explain why in case 2 after stimulation of the right median nerve there was a change just in latency, and after stimulation of the left median nerve there was a change just in amplitude. Whatever the reason for these electrophysiologic changes, it was clear that in both patients aspiration of fluid from the cystic masses improved the transmission of electrical potentials. This situation indicated to the surgeon the high likelihood of improving the patients' symptoms if he were to operate on the cystic lesions. This would be analogous to previously reported cases [11] in which the changes on intraoperative SSEPs correlated closely with the patient's postoperative neurologic status. Significant improvement in the neurologic status of our patients was noted postoperatively.

In conclusion, we believe that the information obtained from the aspiration technique described in this article can allow one to determine objectively the effect of fluid removal from cystic spinal lesions. While this procedure is not offered as a treatment method, it can serve as an indicator of the potential efficacy of surgical decompression of these abnormalities.

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